

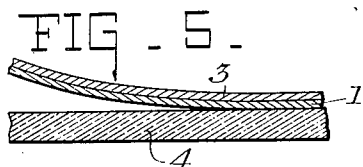
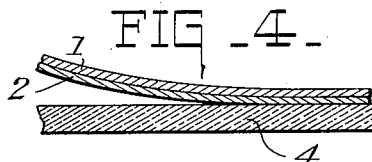
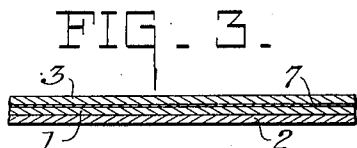
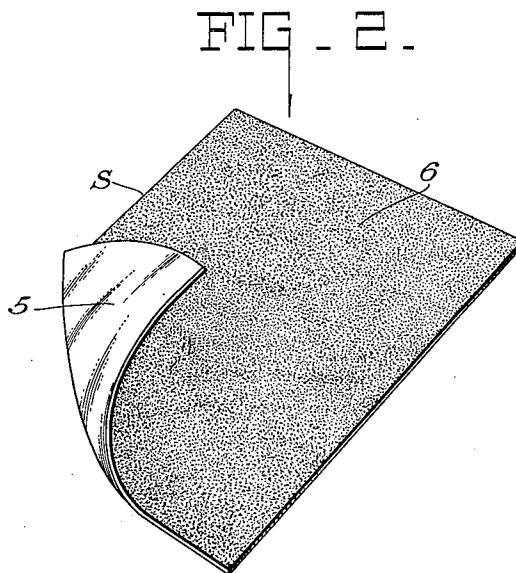
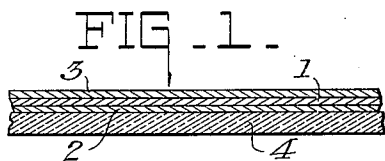
April 7, 1925.

1,532,782

S. E. SHEPPARD ET AL

FLUORESCENT SCREEN

Filed Dec. 14, 1922



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FLUORESCENT SCREEN.

Application filed December 14, 1922. Serial No. 606,942.

To all whom it may concern:

Be it known that we, SAMUEL E. SHEPPARD and LEON W. EBERLIN, a subject of the King of Great Britain and a citizen of the United States of America, respectively, residing at Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Fluorescent Screens, of which the following is a full, clear, and exact specification.

This invention relates to fluorescent screens used to intensify the image produced on a sensitive plate or film by X-rays, and to methods for making the same.

Among the objects of this invention is the production of a screen which has a high intensifying value, which has surfaces capable of being cleaned without injury, which is impervious to moisture, which mechanically is not fragile, in which the layer containing the fluorescent material is well protected from injury, which is flexible and the opposite sides of which are so surfaced as to be readily distinguishable by touch or sight in a dark-room. Other objects are the attainment of simple and reliable methods of manufacture of such a screen. Still other objects will appear hereinafter.

Reference will now be made to the drawings in which the same reference characters designate the same parts throughout and in which—

Fig. 1 is a fragmentary enlarged section of a screen and the plate upon which it is formed;

Fig. 2 is a perspective view of a screen;

Fig. 3 is a fragmentary enlarged section of a modified screen;

Figs. 4 and 5 are fragmentary enlarged sections showing different methods of forming the screen.

Our screen S comprises three layers, a central layer 1 containing a fluorescent material, a thin front protective and supporting layer 2 and a heavy protective and supporting backing 3. The composition and properties of these several layers will be more fully specified hereinafter.

One method of making the screen will now be described by way of example. Upon a smooth surface such as a glass sheet 4, from which the screen as an entity may be later stripped, a thin layer of a cellulosic

compound is spread. This is preferably a solution of cellulose acetate in any suitable solvent. The particular formula of this solution is not of great importance, and one of the many known formulæ, such, for instance, as that given in the patent to Seel, No. 1,342,601, granted June 8, 1920, may be used, enough solvent being used to render it sufficiently dilute if, as we prefer, a very thin film is desired.

This layer may be extremely thin and, therefore, can dry rapidly forming a tenuous smooth film. There is then deposited upon this film a layer of an emulsion comprising very finely divided calcium tungstate in suspension in a solution of cellulose nitrate in butyl acetate, amyl acetate, a mixture of these, or in any other suitable solvent, preferably one which does not dissolve the acetate film first deposited, though the latter is softened sufficiently to produce a weld between the two layers.

This coating is done at room temperature or warmed to a temperature of, say, between 70 and 90 degrees F., for example. Sufficient solvent is used to render the emulsion relatively fluid at ordinary temperatures but the amount of binder, in this instance cellulose nitrate, is very small, usually in the order of 1 to 2 per cent by weight of the amount of tungstate and preferably less than 5 per cent, as we have discovered that more binder reduces the intensifying value of the screen. This layer dries by the slow evaporation of the solvent to a smooth layer or film firmly adherent to the first layer.

There is then coated upon the dry surface by uniform flowing a backing of cellulose nitrate dissolved in butyl acetate or other solvent with a high boiling point, together with a softener such as castor oil. We find that by using in the backing only high boiling solvents of relatively low volatility and fluidity that a softening and deteriorating effect on the emulsion is avoided. Sufficient softening of the emulsion layer must take place to form a weld or adhesion. In the preferred form we use nitrates of lower nitration for the emulsion binder, with amyl acetate as the solvent, and nitrates of higher nitration for the backing, with butyl acetate as the solvent, a perfectly satisfactory junction being effected without harming the

tungstate layer, as these nitrates are more soluble in amyl and butyl acetates, respectively

In making this backing layer we find it highly advantageous to incorporate therein a small amount of a material which will render it readily distinguishable to sight or touch and which will increase the efficiency of the screen. For this purpose we find finely divided metallic aluminum or magnesium, such as is used for bronzing, particularly useful.

When the backing layer 3 dries, it is in optical contact with the emulsion layer 1 and if it contains a material that is opaque to light rays it forms a smooth reflector, returning toward the front of the screen the light rays emanating from the fluorescent material when affected by X-rays, thereby increasing and intensifying the effect of the screen on the photographic emulsion with which it is used. The outer surface of the backing layer, being exposed to the air, dries to a rough or matte condition as indicated at 6, due to the presence of the metallic particles, and furnishes a back having a metallic lustre and reflecting light diffusely. It is thus readily distinguishable by sight in the dimly lighted dark room, because the front surface of the screen is that face of the acetate film that was in contact with the polished glass plate, and is glossy, as indicated at 5, giving high specular reflection; while because of the differences in the surfaces they are readily distinguishable by touch.

In preparing this composition we find that 4 ounces of metal powder and 15 ounces of cellulose nitrate to a gallon of solvent give satisfactory results, but we do not limit ourselves to this proportion. The backing is permitted to dry in the air and then the screen as a whole is stripped from the glass plate.

The amount of metal powder given in the illustration is enough to render the backing opaque to visible light, but because of the low atomic weight of the metal it is insufficient to affect materially the passage of X-rays. It may be stated in this connection that it is a common practice to use screens of this type in pairs, one in contact with each surface of a sensitive plate or film which is coated with sensitive emulsion on both surfaces, and the X-ray must, therefore, pass through one of the screens.

In practice, the following thicknesses of the several layers in the finished screen have been found satisfactory: front or facing film, .0005 in.; fluorescent emulsion layer, .006 in.; backing, .014 in. This is but one example, and we do not restrict ourselves to these dimensions; as it is to be understood that the thickness of the various layers may vary widely.

Having described fully the preferred form of screen and the preferred method of making it, we will now point out certain alternative materials and methods that may be used.

The front or facing layer may comprise a cellulose ether, dissolved in a mixture of chloroform and ethyl alcohol, or in benzol and ethyl alcohol, these not being solvents for the cellulose nitrate used in the fluorescent layer. Or the facing surface may comprise cellulose nitrate while cellulose acetate or cellulose ether is used as a binder for the fluorescent salt.

The first two layers 1 and 2 may be stripped together from the glass plate 4 as indicated in Fig. 4; and the backing formed as a separate film and attached to them by autogenous welding, under heat and pressure in a suitable press. In this case the backing is compounded with sufficient camphor or other plastifier for nitrocellulose to make it soften under heat and pressure.

If the screens are to be used singly, gold or copper particles may be used; and they may be used even if the screens are to be used in pairs; but in this case the amount incorporated in the backing must be very small.

For the purpose of internal reflection, as described, there may be incorporated in the backing, instead of the metals mentioned, a reflecting salt, pigment or filler which will render the backing capable of reflecting visible light without materially affecting the passage of X-rays. Among the materials found suitable are magnesium carbonates, and magnesium and aluminium oxides and silicates. Another filler that may be used in wood flour dyed with aniline or other organic coloring material.

There can also be applied in very small amounts in a thin layer indicated at 7 in Fig. 3, laid directly on the fluorescent emulsion 1, substances such as zinc oxide or sulfide whose fluorescent effect under ultra violet rays emitted by the activated tungstate serves as auxiliary intensification while it also reflects visible light. This reflecting layer may then be followed by the backing 3, which may be transparent, but preferably contains material transparent to X-rays but opaque to ordinary light, such as small quantities of aluminium powder, the chief purpose of which is to distinguish in the dark room the front surface of the screen from the backing.

The screen may be made by flowing the active layer 1 directly on the glass plate 4 and then forming the backing layer 3 thereon, these two layers together being stripped as shown in Fig. 5. In this case the first protective coating can be brushed, as a liquid varnish, on the front surface of the active layer after stripping.

It is to be noted that the screen as described and made is very flexible and rugged enough to withstand all ordinary use. The emulsion layer by itself, because of the small

5 amount of binder would be extremely fragile. It has been customary hitherto to make the fluorescent emulsion by coating and stripping a single film. The reduction of the amount of binder increases the efficiency of the screen, and by the method of first forming a facing film upon which the extremely fragile fluorescent layer is formed it is possible to make and use this more efficient form commercially.

15 We have found in all samples that have come under our observation that cellulose acetate and cellulose ether are more transparent to the light emitted by fluorescence of the salts than is cellulose nitrate and for that reason one of these is desirable for the front protective layer.

The screen is washable and quite impervious to the effects of moisture, as the films are not water soluble nor hygroscopic nor are adhesives of such properties used between the layers. As has already been fully pointed out, the efficiency is very high both because of the small proportion of binder used, and because of the reflecting and intensifying backing. It is also highly convenient because of the ease with which the surfaces may be distinguished under all conditions.

It is to be understood that we do not limit ourselves to the proportions or ingredients enumerated in the specification, but that we consider as included within our invention all such modifications and equivalents as fall within the scope of the appended claims.

40 The composition of the active layer may be, and preferably is, one of the type disclosed and claimed in the copending application of Frank Balch, Serial No. 609,081, filed Dec. 26, 1922.

45 Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. An intensifying screen having a layer containing a fluorescent salt and a rear supporting layer, the supporting layer comprising a cellulosic compound and carrying fine particles of material of a color pronouncedly different from that of the fluorescent salt and rendering the backing layer opaque.

2. An intensifying screen having a glossy front surface and having a backing comprising a cellulosic compound and carrying fine particles of material which render the back surface matte with a metallic lustre and a distinguishing color.

3. An intensifying screen comprising an active layer and a backing layer comprising a cellulosic compound having incorporated

therein fine particles of material which render the back surface matte with a distinguishing color and lustre.

4. An intensifying screen comprising an active layer and a backing layer comprising a cellulosic compound having incorporated therein fine particles of material which render the back surface matte with a distinguishing lustre, the screen having a glossy front surface.

5. An intensifying screen comprising an active layer and a backing layer comprising a cellulosic compound having incorporated therein fine particles of material which render the back opaque to ordinary light but do not materially affect the passage of X-rays, said backing having optical contact with the active layer and reflecting back thereto ordinary light rays therefrom, and said particles rendering the back surface of said screen matte.

6. An intensifying screen comprising an active layer and a backing layer comprising a cellulosic compound carrying fine metallic particles which give the back surface a metallic lustre.

7. An intensifying screen comprising an active layer and a backing layer comprising a cellulosic compound and carrying in suspension fine metallic particles which render the rear surface matte with a metallic lustre.

8. An intensifying screen comprising an active layer and a backing layer comprising a cellulosic compound and carrying in suspension fine particles of a metal of low atomic weight.

9. An intensifying screen comprising an active layer and a backing layer comprising a cellulosic compound and carrying in suspension fine particles of a metal of low atomic weight, the backing layer being in optical contact with the active layer, and its rear surface being matte.

10. An intensifying screen comprising a facing layer and an active layer, the facing layer being a film comprising a cellulosic compound and the active layer comprising an emulsion of a fluorescent salt in a binder comprising a different cellulosic compound, there being in one of the said two layers a solvent for the cellulosic compound therein but which is not a solvent for the cellulosic compound in the other layer.

11. The method of making an intensifying screen comprising the flowing of a solution of a cellulosic compound on a polished surface, permitting said solution to dry, thereby forming a film layer, the flowing thereover of a composition comprising a cellulosic compound in a solvent and carrying in suspension particles of a fluorescent salt, permitting said composition to dry in a layer in adherence with the film first formed and stripping said layers from the polished surface.

12. The method of making an intensifying screen comprising the flowing of a solution of a cellulosic compound on a polished surface, permitting said solution to dry, thereby forming a film layer, the flowing there-
5 over of a composition comprising a cellulosic compound in a solvent and carrying in suspension particles of a fluorescent salt, permitting said composition to dry, forming a sec-
10 ond layer in adherence with the film first formed, and the flowing thereover of a solution of a cellulosic compound, and permitting said solution to dry, forming a layer
15 in adherence with the second layer, and stripping the screen thus formed from the polished surface.

13. The method of making an intensifying screen comprising the formation of a film comprising a cellulosic compound and flow-
20 ing thereover a composition comprising a cellulosic compound in a solvent therefor and carrying in suspension particles of a fluorescent salt, said solvent not being a solvent for the first mentioned cellulosic
25 compound.

14. The method of making an intensifying screen comprising the formation of a layer comprising a mixture of a fluorescent salt in a binder comprising a cellulosic nitrate

of low nitration and the flowing thereover 30
of a solution of cellulosic nitrate of higher nitration in a solvent that has greater solvent action on the second named nitrate than on the first.

15. An intensifying screen comprising a 35
facing layer and an active layer, the facing layer being a film comprising a cellulosic compound and the active layer comprising a mixture of a fluorescent salt and a binder comprising a different cellulosic compound. 40

16. An intensifying screen comprising a facing layer and an active layer, the facing layer being a film comprising a cellulosic compound and the active layer comprising a mixture of a fluorescent salt and a binder 45
comprising a different cellulosic compound, the facing layer being particularly transparent to fluorescent light.

17. An intensifying screen comprising a facing layer and an active layer, the facing 50
layer being a film comprising cellulose acetate and the active layer comprising a mixture of a fluorescent salt and cellulose nitrate.

Signed at Rochester, New York, this 7th 55
day of December, 1922.

SAMUEL E. SHEPPARD.
LEON W. EBERLIN.